devices that would otherwise have to use modems and PSTN connections for data and voice communications. An optional Global Positioning System (GPS) capability can be integrated into terminals to provide location-dependent information.

The system is designed to enable interactive wireless communications at data rates up to 8 Mbps. A broad range of applications ranging from voice to E1 (2 Mbps) web-browsing to high-speed data transfer will be available. Connection routing is accomplished with packet switching on the satellite for global mesh-connectivity.

System Access Nodes will provide users a transparent connection with various terrestrial networks. Control Centers consist of a Satellite Control Center and Network Operations Control Center. The StarLynx™ system is depicted in Figure 1.1-1, and the key features are shown in Figure 1.1-2.

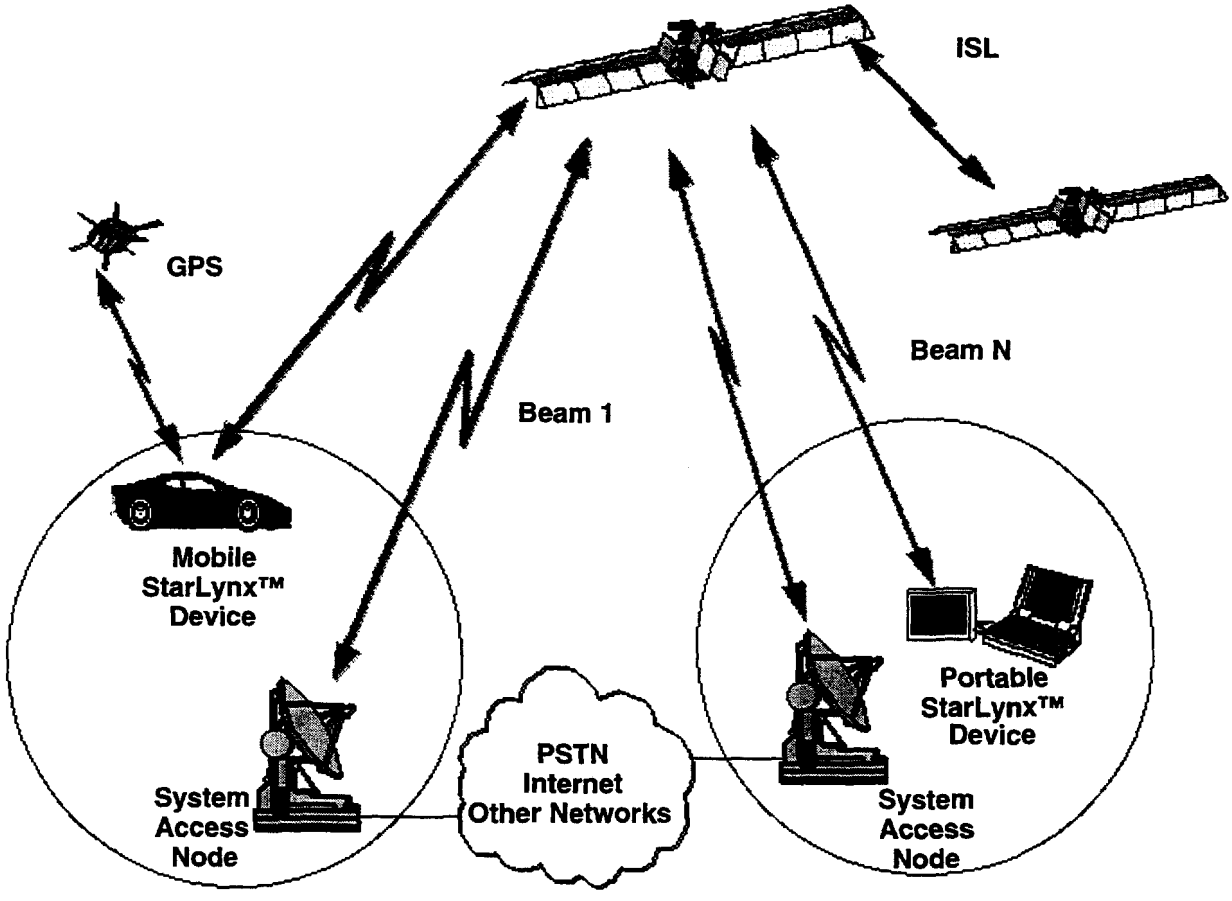


Figure 1.1-1. The StarLynx™ System

- Mobile and Portable Service to Small Terminals
- Variable Data Rate Capability (4 Kbps to 8 Mbps)
- Hybrid GSO/MEO Satellite Constellation
- 10 Times Spectrum Reuse per Satellite
- Selectable Coverage Area Provided by Narrow Spot Beams
- Satellite Processor
- Laser Intersatellite Links

Figure 1.1-2. Key Features

1.2. Points of Contact for Applicant

1.2.1. Name, Address, and Phone Number of Applicant

Hughes Communications, Inc.
1500 Hughes Way
Long Beach, CA 90810
Attn: Jerald F. Farrell, President
(310) 525-5010
cc: Scott Tollefsen, Vice President, General Counsel & Secretary
(310) 525-5150

1.2.2. Name, Address, and Phone Number of Contact

Gary M. Epstein
John P. Janka
Arthur S. Landerholm
Latham & Watkins
1001 Pennsylvania Avenue, N.W., Suite 1300
Washington, DC 20004
(202) 637-2200

1.2.3. Type of Authorization Requested

HCI requests authority to launch and operate a total of four GSO satellites at two orbital positions and 20 MEO satellites. The GSO orbital positions for which HCI is requesting authority are 99°W and 101°W. The MEO satellites will be in circular orbit at an equatorial altitude of 10,352 km, with four planes and five satellites per plane inclined at 55 degrees with respect to the equator.

Public Interest

2. PUBLIC INTEREST CONSIDERATIONS

StarLynx™ will provide communications capabilities that will significantly contribute to the National Information Infrastructure (NII) and Global Information Infrastructure (GII) by making available high data rate, mobile and portable wideband communications on demand throughout the world. StarLynx™ will provide high speed access to the Internet in particular and multi-rate, multi-functional telecommunications services in general. The innovative design of the system ensures that this capability can be provided at low cost with a quick deployment time.

In response to the large increase in traffic on the PSTN created by Internet use, deployment of alternative paths for data traffic is a vital U.S. national interest, especially for users beyond the reach of conventional networks. StarLynx™ will create a novel mobile and portable data infrastructure that is otherwise not available and will support a wide range of voice, image, and data communications services.

The benefits of StarLynx™ to American commerce and industry are manifold. With its high data rate mobile telecommunications capability, StarLynx™ will support commercial communications ranging from high speed information transfers to interactive multimedia exchanges between businesses and customers currently unreachable by existing systems, thereby creating new efficiencies and productivity for mobile industries such as real estate, construction, media, and health services. This new capability will significantly expand the United States economy, as well as greatly increase the competitiveness of U.S. enterprise in the global economy.

Developing countries will be able to use StarLynx™ to improve their own national telecommunications infrastructures without the high costs and delay of installing towers, laying cable, and building terrestrial wireless facilities in all areas. StarLynx™ will also significantly expand connectivity for users in developed regions of the world.

Construction of the StarLynx™ system will in large part be accomplished by HE, an American telecommunications company. The space segment will consist of satellites that will be manufactured at the Hughes Space and Communications plant in El Segundo, California. Ground terminals will be manufactured by Hughes Network Systems of San Diego, California, and Germantown, Maryland, and other U.S. suppliers. The commitment by Hughes to use its U.S. manufacturing and construction facilities to build StarLynx™ will result in the creation of numerous highly skilled, professional jobs for Americans.

3. MARKET FOR SERVICES

3.1. OVERVIEW

The mobile and portable communications market is expanding at a rapidly increasing rate. This growth will support a much broader use of wireless services. Mobility is already a key feature in new computer and peripheral products and soon will be a basic requirement for these products.

A variety of mobile interactive information systems exist today, including dedicated mobile data networks, cellular, two-way paging, and other data systems. These current mobile systems provide voice, fax and data communications with data rates ranging from 4 kbps to 100 kbps. Wireless data services provide dispatch services, two-way paging, and network connections to meet business requirements. However, current services, including PCS, are limited in bandwidth and data rate capabilities and require extensive and costly infrastructure buildout. Moreover, in many cases, access to paging, cellular, PCS, and other mobile data services requires a separate device for each type of service, thereby posing a major disadvantage for users.

StarLynx™ will provide a wide range of high data rate communications services to mobile and portable users. No current or announced system, terrestrial or satellite, provides all the capabilities that StarLynx™ offers. StarLynx™ meets the needs of the new business professionals who are dependent on immediate access to up-to-the-minute data wherever their locations.

Wiring the globe for high data rate wireless mobile and portable terrestrial communications would cost trillions of U.S. dollars and take decades. In contrast,

the rapidly deployable StarLynx™ network can provide universal availability of these high data rate mobile and portable services sooner and at a lower cost than any global terrestrial network.

3.2. Market Demand

Growth projections of portable computing device users forecast that by the year 2000, one out of every two workers will use such portable devices (Figure 3.2-1). These portable devices, including laptop and palmtop computers, personal digital assistants, smart phones, and network computers, have projected compound annual growth rates greater than 75%.

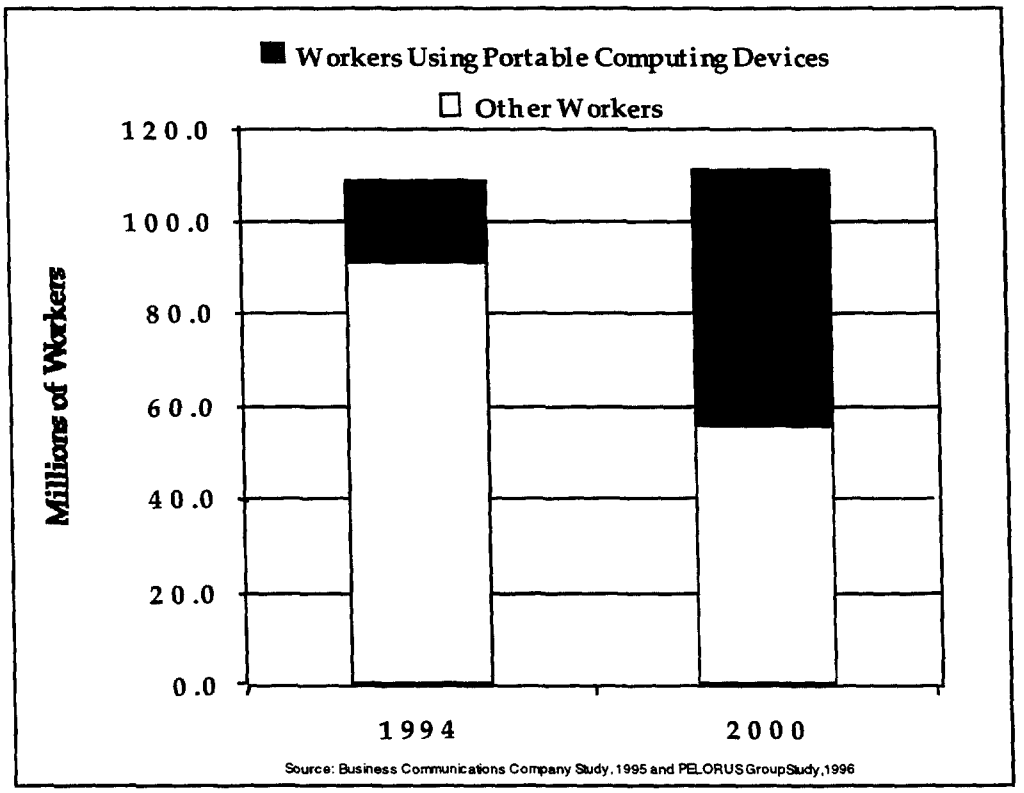


Figure 3.2-1. Growth in the U.S. Workforce Using Portable Devices

By the year 2000, approximately one fifth of the world's population will have access to wireless services, voice, and data. It is estimated that 25% of those who have wireless access will use it for data applications. The market demand for

interactive mobile services has many significant components, which are discussed below.

3.2.1. Growth of the Enterprise Mobile Environment

Initially, wireless messaging and file transfer were the only data applications available to mobile workers. As use of the Internet has exploded, an urgent demand for new wireless data applications and for an expansion of wireless data capabilities has developed. The convergence of critical components has spurred the creation of a new technology sector -- enterprise mobile computing (EMC).

EMC is based on the need to develop a mobile computing/communications system to respond to changing business practices and workforce habits. A key component of EMC is the ability to get information and make decisions while physically separated from the location of the organization. Characteristics of EMC include: access to applications central to business operations, a hybrid of wired and wireless communications, middleware that links different devices, networks and software, and system integration to create solutions for the enterprise.

3.2.2. Customer Needs

Manufacturers of handheld devices have identified the primary needs of their customers as availability, effectiveness, interoperability, customer service, and cost. For users, Internet access and the ability to interface with their desktop computers are imperative. The StarLynx™ system will provide the key features users want: convenient, high data rate, affordable, and seamless connections to a wide variety of networks. StarLynx™ will enable high data rate communications that are cost-

insensitive to distance and give users the ability to work anywhere and collaborate effectively on virtually any task.

3.2.3. Market Segments

Sectors that have a greatly increased need for mobile communications include financial, manufacturing, construction, trade, services, and home workers. In the financial industry, banks, insurance companies, real-estate firms, financial managers, accountants, and auditors will use StarLynx™ services when they are "on the road" for real-time stock and price quotes, portfolio and account management, and videoconferencing. The manufacturing components of all industries will use StarLynx™ to support and coordinate the production process between factories and remote sites.

In the construction industry, architects and civil engineers will be able to transmit design information to and from construction sites, wherever they are located, around the world. The trade segment, comprised of wholesale, retail, transportation, and warehousing, will use StarLynx™ to maintain communication links along all points of the distribution chain. In the services industries, StarLynx™ will enable healthcare services, advertising, management consulting, legal services, entertainment, engineering, and scientific service providers to access large databases and to transport large files of time-sensitive information to and from any remote site. The rapidly growing number of small office/home office workers, which includes professional/technical consultants, telecommuters, and self-employed workers, will use StarLynx™ to keep in contact with clients through e-mail, audio/videoconferencing, and interactive workgroups.

Figure 3.2.3-1 shows the estimated 17.3 million U.S. portable computer users in six major segments, based on 1994 data, providing a very conservative indication of the potential number of users for StarLynx™ services.

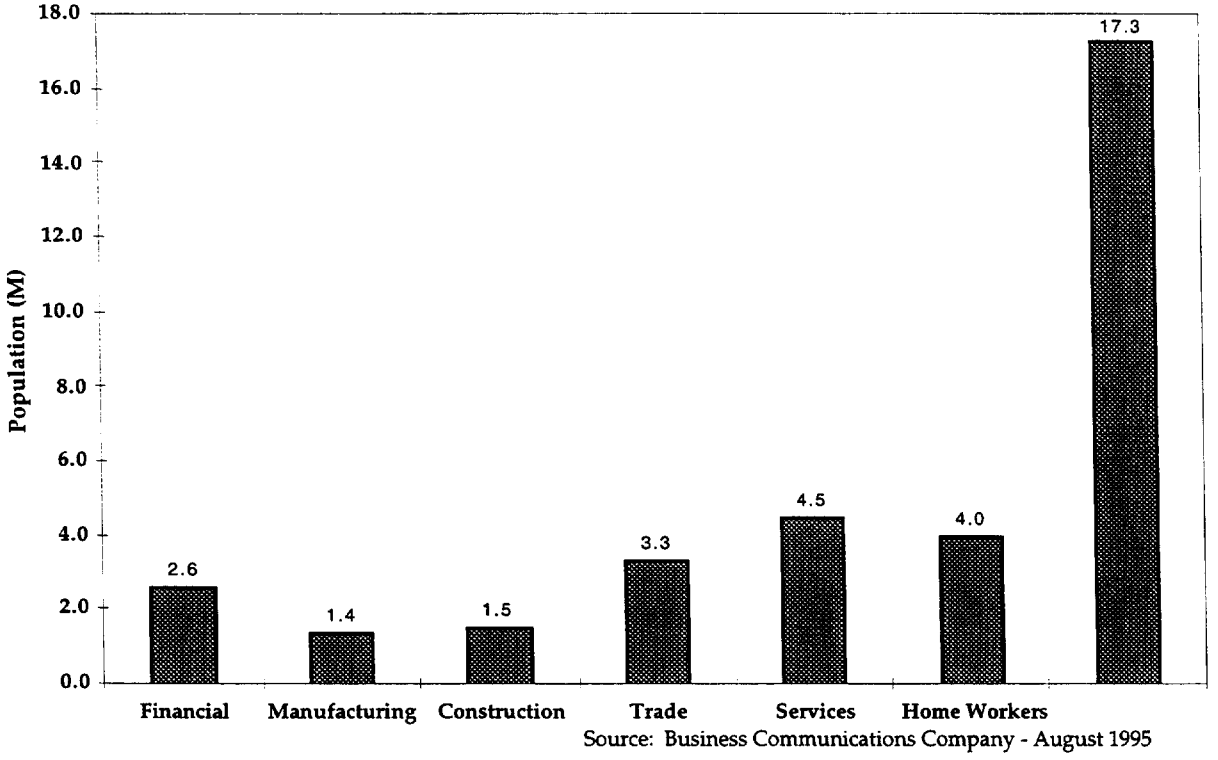


Figure 3.2.3-1. U.S. Portable Device Users by Market Segment

3.3. TECHNOLOGY ENABLERS

3.3.1 Applications

Future mobile applications will feature a synergistic blending of audio and video with traditional data that will permit users to communicate through networks using sound and images extensively. Many of these applications will call for interactive symmetric networking. Examples of new applications that will be widespread include audio/videoconferencing, computer-based training, video distribution, interactive television, collaborative design, industrial control, and interactive games.

The demand for interactive multimedia traffic in a mobile environment is enabled by innovations in network protocols, terminal miniaturization and video technology. To accommodate the high data rates needed for multimedia applications, large amounts of bandwidth, such as are available at V-band, will be required. StarLynx™ takes advantage of the latest technological innovations in satellite design including: vastly improved power available for communications, narrow spot beams, digital switching and optical ISL.

3.3.2. User Equipment

Through improved input methods, such as voice recognition and pen-based graphical interfaces, mobile and portable devices will become much more powerful and flexible. Continuing increases in computing power, reductions in device sizes, and decreases in device costs will result in greatly increased use of these devices.

3.4. Proposed Services

StarLynx™ will provide a wideband satellite communication service that allows users to connect to a wide variety of networks: PSTN, Internet, LANs, WANs, and others. Using a flat, thin, portable device approximately 30 X 30 cm in size, users will be able to stay in touch anywhere with two-way data rates of up to 2 Mbps. The devices will provide Internet access, e-mail, interactive workgroup applications, video conferencing, voice/fax capabilities, and interactive entertainment services.

StarLynx™ will also operate with a 60 x 60 cm antenna. This vehicle-mounted device, operating at data rates up to 8 Mbps, will provide users with all the capabilities of the portable device, as well as enhanced features that require higher

data rates, such as video downloading and large database and image transfer capabilities. Optional integrated GPS electronics will provide location-dependent information for additional applications. The vehicle device will also support intelligent navigation services, which will aid enterprise mobile workers in traffic, routing, and delivery tracking. StarLynx™ will enable mobile accident reports, calls for assistance, stolen vehicle tracking, and remote car door unlocking, for example, and will make these services available universally and at a lower cost than is possible today. StarLynx™ will also give airplane, train, truck, and automobile passengers access to video and audio entertainment of their choice.

StarLynx™ will give users with data-intensive applications the ability to roam freely within an office or school campus, in the wilderness, and while traveling and still maintain access to any network. Filmmakers will be able to create virtual studios on location anywhere. Medical personnel will be able to call up high-resolution images. Engineers will be able to download complex drawings and designs and to diagnose and repair equipment on site. Emergency-service workers will be able to photograph and transmit situational information immediately. Realtors will be able to transmit videos of property to mobile consumers. Educators will be able to call up color photographs and videos from any source and display them on handheld, portable and desktop computers in off-campus classrooms. Movie producers will be able to receive and transmit their work from remote locations.

THIS PAGE INTENTIONALLY LEFT BLANK

4. SYSTEM DESCRIPTION

4.1. SUMMARY OVERVIEW

StarLynx™ provides high data rate services to small portable and mobile terminals using V-Band spectrum through a hybrid GSO/MEO satellite constellation. The portable terminals (30 x 30 cm) can operate at up to 2.048 Mbps, and the mobile terminals (60 x 60 cm) can operate at up to 8.19 Mbps. This high data rate service to small teminals is possible because the system design employs high power and highly-directive spacecraft antennas beams and efficient signal design techniques (including coherent CDMA).

The space segment constellation consists of four GSO and 20 MEO satellites providing global coverage. User subscribers can make data requests via satellite and receive mobile downloads on demand from any digital data bank through the StarLynx™ System Access Node (SAN) links. An onboard regenerative and routing processor as well as steerable satellite antenna receive and transmit beams afford additional operational flexibility.

The ground segment Network Operating Center (NOC) works with the satellite onboard processor to control the user access requests. In addition it monitors service availability and capacity, beam management, and handovers throughout the system.

4.2. SIGNAL DESIGN AND FREQUENCY PLAN

The V-band spectrum affords wideband capacity and high data rates while using relatively small antenna apertures on the satellite and terminal. The frequency plan design employs extensive re-use of the V-band spectrum.

The practical design of the satellite antenna arrays requires that no adjacent beams at the same frequency be used in order to achieve adequate spatial isolation between each area beam. Use of Right and Left-Hand Circular Polarization (RHCP and LHCP) for the entire 1.1 GHz of requested bandwidth further increases isolation between adjacent beams. Utilizing the high frequency V-band, the relatively small satellite antenna apertures required to form small beamwidth footprint areas, and dual polarizations, the spectrum can be reused ten times per satellite.

The signal structure accommodates the maximum data rate of 8.192 Mbps to mobile devices. The selected baseband modulation is Quadraphase Shift Keying (QPSK), with convolutional-concatenated, Reed-Solomon, error-correction coding. Large clock interleaver registers are also used to address shadowing fades.

StarLynx™ uses a combination of FDMA (Frequency Division Multiple Access) and CCDMA (Coherent Code Division Multiple Access) to orthogonalize the user signals. The signal design allows flexible data rates. Reducing the data rate in binary ratios correspondingly increases the number of users that can be accommodated in a particular CDMA slot.

The selected sub-beam bandwidth is 270.336 MHz. This allows three FDMA slots per sub-beam. This design, together with dual polarization, increases isolation between adjacent beams and allows dense coverage of high demand areas. One of two different beam laydown patterns will be chosen in a given geographic region, depending on demand.

Figure 4.2-1 shows the sub-beam frequency and polarization options and an illustrative beam laydown pattern for the GSO and MEO satellites. In areas of high

demand, two 257-MHz band segments can be deployed to maximize service capacity in the same geographic area (the dual beam pattern). Figure 4.2-2 shows the detailed frequency plan for GSO and MEO satellites.

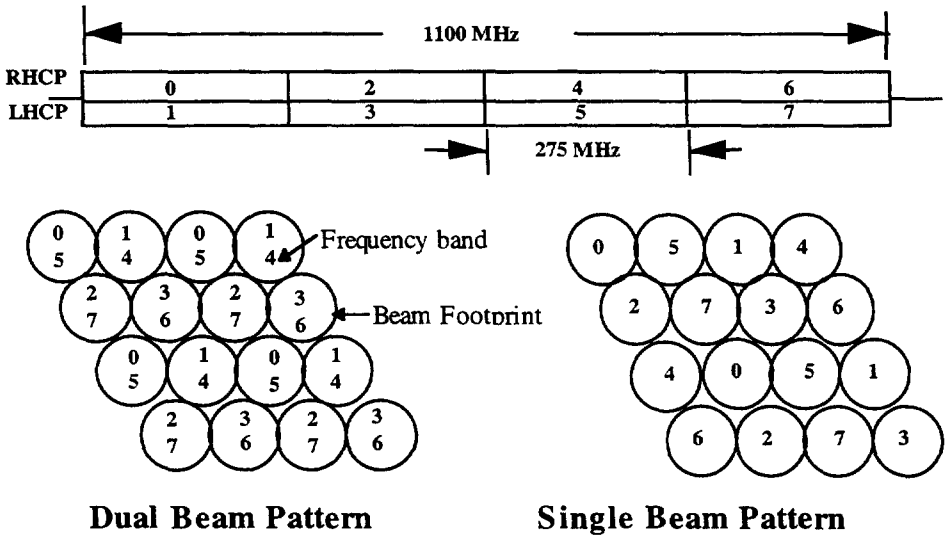
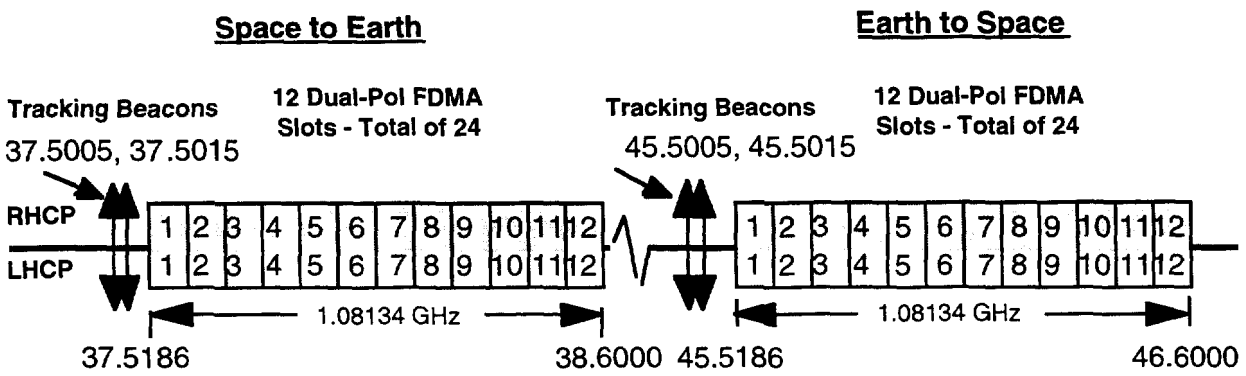
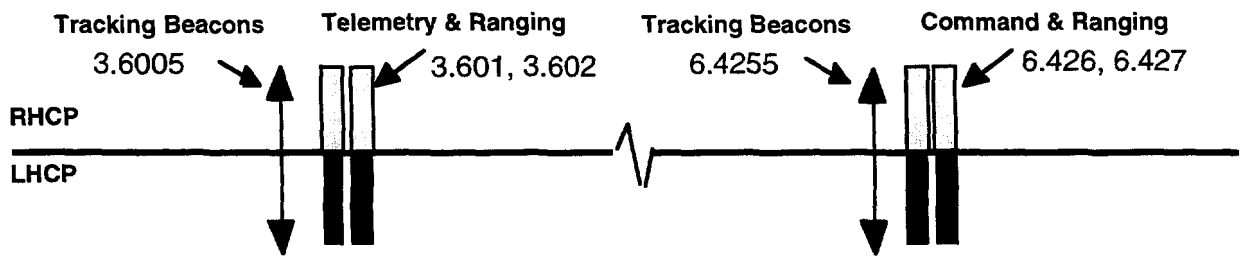


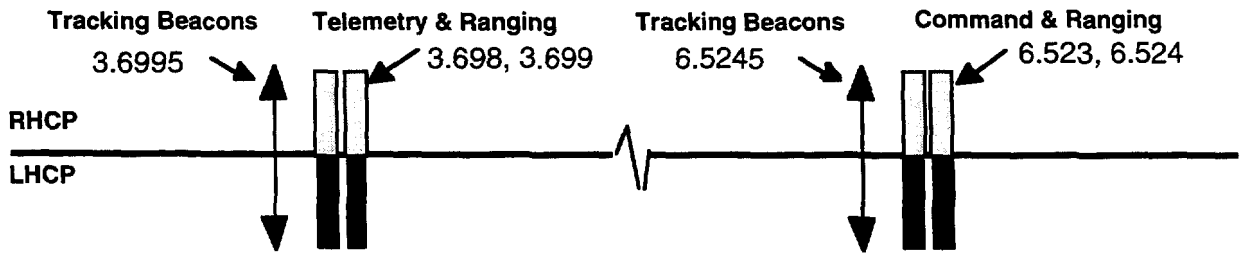
Figure 4.2-1. GSO and MEO Beam Frequency Options



a) V-Band Communications



b) MEO C-Band Command, Telemetry, Ranging & Beacons



c) GEO C-Band Command, Telemetry, Ranging & Beacons

Figure 4.2-2. GSO and MEO Frequency Plan

Both the MEO and GSO satellites use the same uplink and downlink bands. The uplink frequency spectrum is 1.1 contiguous GHz within 45.5 to 46.7 GHz and the downlink frequency spectrum is 37.5 to 38.6 GHz. Figure 4.2-3 illustrates the signal design.

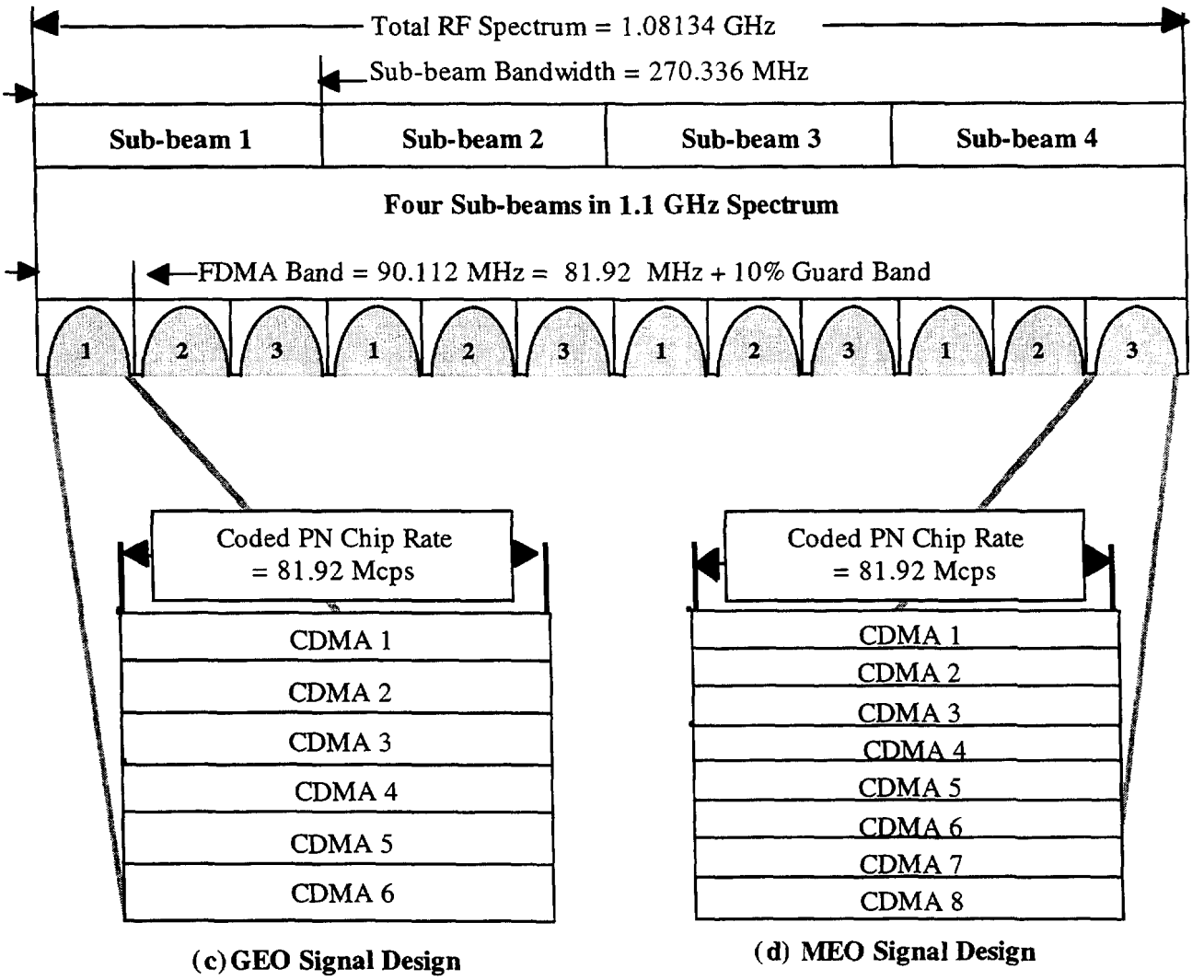


Figure 4.2-3. FDMA/CDMA User Multiple Access Design

4.3. Emission Designators

Table 4.3-1 lists the emission designators for the StarLynx™ system communications links.

Table 4.3-1. Emission Designators

Signal	Number of Emmissions	Emission Designator
V-Band Communications Uplink	24	90M0G7DDC
V-Band Communications Downlink	24	90M0G7DDC
C-Band Command	8	1M50G9DXF
C-Band Telemetry	8	1M50G9DXF
C-Band Beacon Uplink	4	100KNONXN
C-Band Beacon Downlink	4	100KNONXN
V-Band Beacon Uplink	4	100KNONXN
V-Band Beacon Downlink	4	100KNONXN

4.4. Power Flux Density (PFD) Compliance

StarLynx™ system requires various communication links including: (1) V-band data, (2) V-band beacon, (3) C-band TT&C, and (4) C-band beacons for satellites in both GSO and MEO constellations. Per Section 25.208(c) of the Commission's Rules and international Radio Regulation (RR) S21-16, the required PFD thresholds for elevation angles above 25° are listed in Table 4.4.1.[1]

Table 4.4-1. Limits of PFD from Space Station

Frequency Band	Max PFD Limit	Elevation Angles	Frequency Range	Regulatory Reference
V	-105 (dBW/m^2) in 1 MHz	25°-90°	37.0-40.5 GHz	RR S21-16
C	-142 (dBW/ m^2) in 4 kHz	25°-90°	3.4-4.2 GHz	RR S21-16

For medium Earth orbit, the maximum power flux density at V-band in any 1 MHz is:

$$\text{EIRP} - 10 \log (4 \pi r^2) - 10 \log (270) =$$
$$55.8 - 10 \log (4 \pi 10{,}352{,}080^2) - 24.3 =$$
$$-119.8 \text{ dBW/m}^2\text{/MHz}$$

where 270 MHz is the signal occupied bandwidth.

---

[1] StarLynx™ system provides communications to areas above 30° elevation angle through small spot beams. PFD values to areas below 25° elevation angle are at least 20 dB below the value at beam peak and thus are omitted in Table 4.4.2.

For geostationary orbit, the maximum power flux density at V-band in any 1 MHz is:

$$70.5 - 10 \log (4 \pi 35{,}788{,}293^2) - 24.3 =$$
$$-115.9 \text{ dBW/m}^2\text{/MHz}$$

These values are for a 90° angle of arrival. For any other angle of arrival, the free space loss will be higher, resulting in a lower power flux density on the ground.

The beacon and telemetry signals maximum PFDs are summarized in Table 4.4-2. These values are within the limits of CFR § 25.208 and RR S21-16 as listed in Table 4.4-1.

Table 4.4-2. StarLynx™ PFD

Signal	EIRP (dBW)	Slant Range (km)	Sig/Req. BW Ratio (Hz)	StarLynx™ PFD	PFD Limit	PFD Unit
GSO Feeder Link (V)	70.5	35788	(270/1)M	-115.9	-105	(dBW/m^2/MHz)
MEO Feeder Link (V)	55.8	10352	(270/1)M	-119.8	-105	(dBW/m^2/MHz)
GSO Telemetry (C)	8	35788	(1500/4)K	-179.8	-142	(dBW/m^2/4kHz)
MEO Telemetry (C)	8	10352	(1500/4)K	-169.0	-142	(dBW/m^2/4kHz)
GSO Beacon (V)	12	35788	NA	-150.1	-105	(dBW/m^2/MHz)
MEO Beacon (V)	12	10352	NA	-139.3	-105	(dBW/m^2/MHz)
GSO Beacon (C)	9	35788	NA	-153.1	-142	(dBW/m^2/4kHz)
MEO Beacon (C)	9	10352	NA	-142.3	-142	(dBW/m^2/4kHz)

4.5. Space Segment

GSO and MEO satellites will be Hughes high-power, three-axis body-stabilized vehicles, and will be an extension of existing Hughes product lines. All GSO satellites will be technically identical, and some or all of them may scan their beams to cover larger areas of the U.S. Intersatellite links will utilize a laser (optical) communication payload.

Figure 4.5-1 illustrate the GSO satellite. Tables 4.5-1 and 4.5-2 provide a summary of GSO and MEO satellite characteristics.

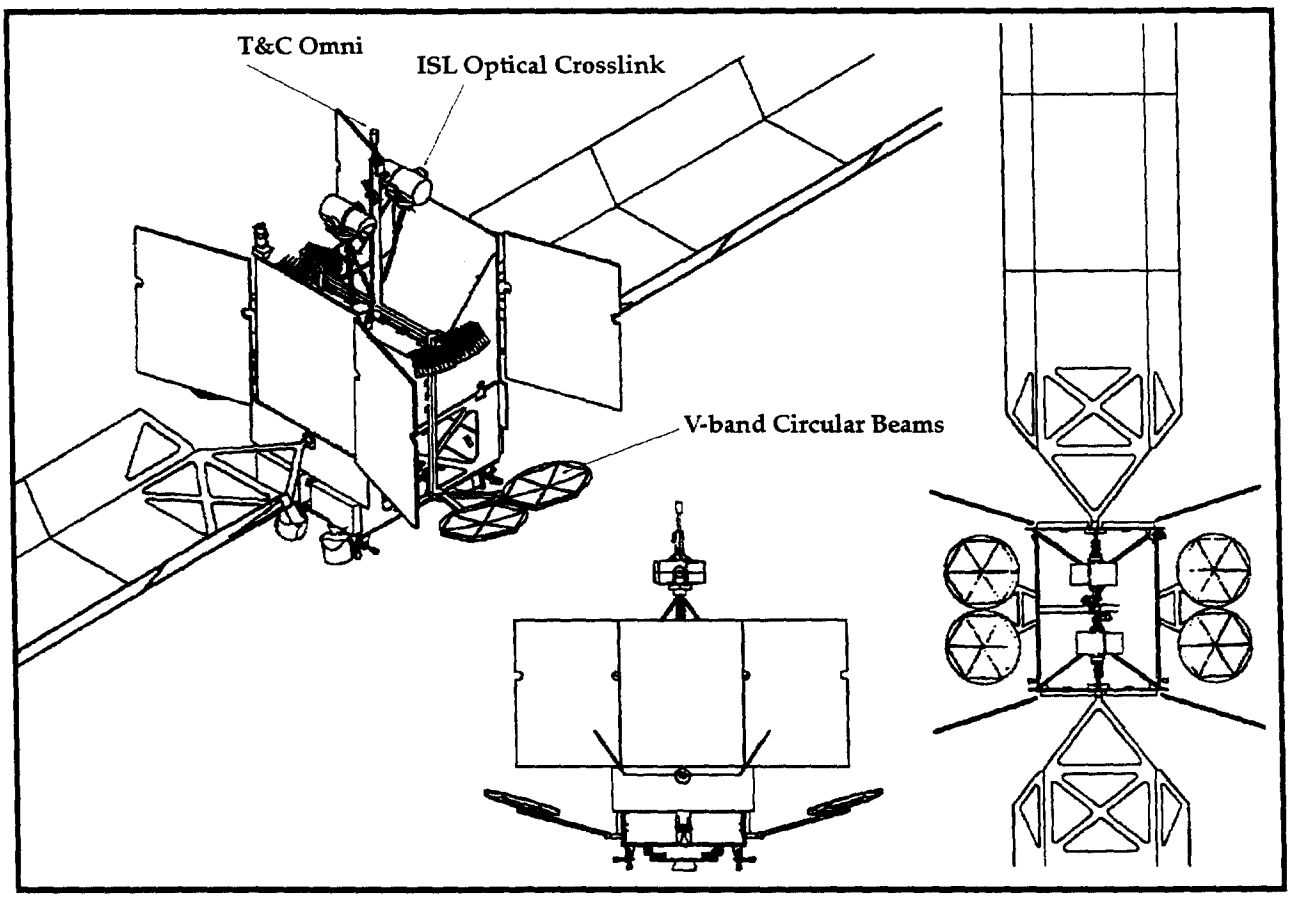


Figure 4.5-1. GSO Satellite

Table 4.5-1. General Characteristics of GSO StarLynx™ Satellite

Satellite Bus	Derived from Hughes' GSO Product Line
Mission Life	15 Years End-of-Life
Stabilization	3 Axis Earth Sensor and Beacon Momentum Wheels and Thrusters
DC Power	17 KW Beginning-of-Life 15 KW End-of-Life
Eclipse Capability	100%
Approximate Weight	5500 Kgs with Propellant 3500 Kgs without Propellant
Uplink Data Antenna	2 V-Band Reflectors
Downlink Data Antenna	2 V-Band Reflectors
T&C Antenna	C-Band Uplink Antenna Command Receive C-Band Downlink Antenna Telemetry Transmit C-Band Omni Antenna
Number of CMD Channels	2
Number of TLM Channels	2

Table 4.5-2. General Characteristics of MEO StarLynx™ Satellite

Satellite Bus	Derived from Hughes' MEO Product Line
Mission Life	12 Years End-of-Life
Stabilization	3 Axis Earth Sensor and Beacon Momentum Wheels and Thrusters
DC Power	17 KW Beginning-of-Life 15 KW End-of-Life
Eclipse Capability	100%
Approximate Weight	3500 kgs with Propellant 3050 kgs without Propellant
Uplink Data Antenna	4 V-Band Receive arrays
Downlink Data Antenna	4 V-Band Transmit arrays
T&C Antenna	C-Band Data Antenna Command Receive C-Band Data Antenna Telemetry Transmit C-Band Omni Antenna
Number of Command Channels	2
Number of Telemetry Channels	2